Development of a Rapidly Installed Breakwater (RIB) System

by Jimmy E. Fowler,[1] Cheryl B. Pollock,[1] Donald T. Resio,[2] and George F. Turk[1]

Introduction

Engineers and scientists at the U.S. Army Engineer Waterways Experiment Station (WES) Coastal and Hydraulics Laboratory are developing a rapidly installed breakwater (RIB) system specifically designed to address problems associated with the efforts of U.S. armed forces to offload ships during Logistics Over The Shore (LOTS) operations. During such operations, problems arise when seas become sufficiently energetic to limit capabilities of ship-based crane operators and stevedore crews. The RIB system is designed to address this documented deficiency by creating a 'pool' of calmer water where these operations can occur so that crews will be able to continue to function.

For many years, WES has been involved with the design and deployment of floating breakwaters, primarily for application within bays or estuaries which are semi-protected from large waves. Such structures typically are intended to attenuate waves with heights not exceeding 4 ft and periods not exceeding 4 sec. Extrapolation to an open ocean environment is at least an order of magnitude greater in difficulty. In an oceanic environment, waves with heights up to 10 ft are common during storm conditions, with associated periods up to 10 sec. Previous tests have shown that to be effective, floating breakwaters must have widths on the order of 1/4 of the wavelength being attenuated, and hence, be very massive to be effective. Such structures are simply not feasible for most temporary floating breakwater applications, since it would be necessary to transport large volumes of a massive structure to the site being sheltered. This problem was the driving force behind recent floating breakwater (RIB system) developments at WES.

During energetic seas, the primary problem occurs in key offshore areas (anchorages) where containerships and roll-on/roll-off (RO/RO) vessels discharge cargo and unit equipment onto much smaller vessels (collectively termed lighterage). A tactical auxiliary crane ship anchorage for offloading containerships at sea is shown in Figure 1, and an RO/RO anchorage for offloading rolling stock (tanks, trucks, trailers, tractors, etc.) is

Figure 1. Typical crane ship offloading operations during low sea state

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shown in Figure 2. To date, research efforts have concentrated on military applications for the RIB system; however, it is anticipated that additional studies will be forthcoming focusing on non-military applications. Potential civil applications include rescue and recovery operations, exposed marine construction operations (e.g., bridge repair, rubble-mound breakwater construction), temporary small vessel/watercraft shelter from energetic seas, and exposed dredging operations.

The LOTS Challenge for Today's Military

Force projection requires moving large quantities of personnel, equipment, and supplies, predominantly via sea lift. Desert Storm/Desert Shield and Provide Comfort operations are recent examples (wartime and peacetime) of U.S. military requirements to deploy and sustain forces. Due to the nature of these operations (wartime scenarios will likely include damaged fixed ports, and peacetime humanitarian relief operations are likely to be conducted in less developed areas of the world with substandard port facili-

ties initially), nearly all foreseeable sustainment efforts will likely require LOTS operations to be successful.

LOTS operations typically involve RO/RO ships, auxiliary crane ships, containerships, and large tankers that anchor offshore in deeper water (Figures 1 and 2). When wave conditions permit, smaller watercraft (lighters) ferry the ships' cargo to various offloading points along the shore. The Department of Defense has a requirement that offloading operations continue through a sea state 3 condition (wave heights up to 5 ft). The critical problem to be addressed during LOTS operations is the demonstrated inability to effectively conduct offloading operations when wave climate conditions exceed what is commonly termed sea state 2 (wave heights up to 3 ft). The troublesome condition described above is commonly known as the 'sea state 3 problem,' and exists when significant wave height exceeds 3 ft with wave periods about 6 sec. The military considers the sea state 3 problem to be critical, since these conditions exist a significant percent of the time worldwide. The sea state 3 problem is considered to be a potential "war stopper" for present force projection plans and technology.

The strategy under consideration involves deploying the RIB system prior to the development of a sea state 3 condition so that calmer water will exist in the immediate vicinity of the anchorages below the sea state 3 threshold. With this scenario, crane operators and stevedore crews could continue to function during open-ocean sea state 3 and even greater, since existing lighters can operate effectively in sea state 3 once safely loaded. An efficiently performing RIB system would cause the limiting sea state condition to be determined only by capabilities of the various lighterage and equipment being used during the LOTS operation.

The RIB System Concept

WES has a long history of solving practical wave problems. WES engineers and scientists are presently in the process of developing the RIB system to address the military's LOTS dilemma. The RIB system consists of a V-shaped structure in plan view, with rigid vertical curtains extending from the surface of the water toward the bottom for a distance sufficient to preclude excessive wave energy from penetrating beneath the structure (Figure 3). When deployed, the tip of the V is oriented into approaching waves, and works by spreading and reflecting incoming waves. Incident waves are 'trained' away from the interior of the V, providing a sheltered area inside the V and in the lee of the structure. Ships and lighterage are moored in the lee of the V for offloading.

Depending on the specific location where the RIB system is to be employed, the length of the legs of the V will vary, but may range between 700 and 1,000 ft. The two legs are joined at the front of the RIB system via a 'nose buoy' which acts as a docking station and allows the interior angle of the legs to vary between 0 and 60 deg. This design allows the legs to be linked together and stream directly behind when the RIB system must be towed to alternate locations. Mooring loads are
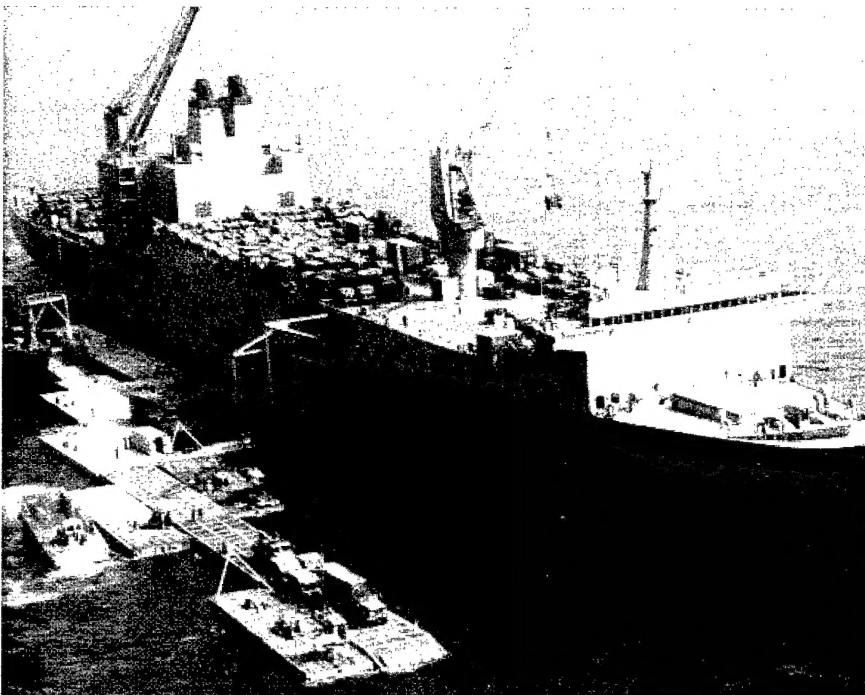

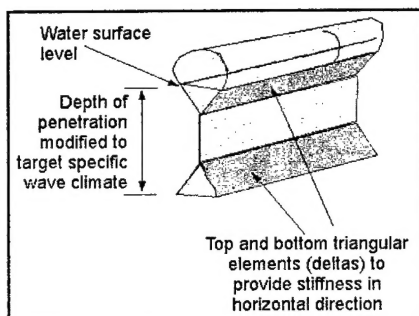*Figure 2. Typical roll-on/roll-off operations during low sea state*

Figure 3. Double delta version of the RIB system

minimized since the structure is designed to deflect waves rather than absorb them. Since the structure is oriented at an oblique angle relative to approaching waves and is several wavelengths long, the oscillatory nature of the wave forces also results in a smaller net force on the mooring lines. The positive forces associated with the crest are simultaneously reduced by the forces associated with the trough which acts in the opposite direction.

Physical Model Experiments

During the early stages of the RIB system development, scale model tests were conducted at WES and Oregon State University to test the concept, refine the initial design, and subsequently to test enhancements and various modifications. Results indicated that a significant 'offshore' area could be effectively reduced from sea state 3 to sea state 1 by the RIB system. The objective of the experiments was to obtain data documenting wave height reduction in the lee of the RIB system for various combinations of leg length, water penetration, and stiffness of the RIB. The experiments were conducted using multidirectional waves with both frequency and directional spreading. Wave heights were recorded at 15 locations throughout the sheltered region to ascertain diffraction effects around the ends of the RIB system.

Results of the most favorable tests using a single RIB system indicated that it was possible to obtain up to 83 percent attenuation. Based on these promising laboratory results, a field deployment was planned and executed in the spring of 1996.

RIB System Field Demonstration

The field study was performed at WES's Field Research Facility located on the Outer Banks of North Carolina near Duck, NC. Since the model was constructed at a 1-to-4 model-to-prototype scale, open-ocean deployment was not feasible, and the somewhat milder wave climate of the Currituck Sound was selected for test and evaluation. The RIB system deployed at Duck consisted of a combination of welded steel structure and closed cell foam floatation. The model was designed as a modular system capable of being assembled using simple hand tools on the beach at Currituck Sound.

The deployment featured two 150-ft-long RIB system legs which were assembled from 30 RIB system modules and a nose buoy which was designed and constructed to expedite connecting the two legs. Each leg was assembled

on the beach and subsequently towed into deeper water where it was joined to the previously positioned nose buoy. Following attachment to the nose buoy, the trailing ends of each leg were attached to pre-positioned anchors to achieve the desired V configuration. Instrumentation to measure wave height and weather conditions, along with video recordings, was used to document the effectiveness of the model during the field investigation. During the 2-week period the RIB system was successfully deployed, data were collected to document wave reduction capabilities and allow comparison to the laboratory data. Figure 4 is a photograph of the RIB system as it was configured during the field deployment.

Comparison of the field data with the laboratory data indicated that the mid-scale field deployment performed quite similarly to the laboratory version, again reducing incoming wave heights by about 75 percent (Figure 5). Results are presented as the ratio of recorded reduced wave height divided by measured incident wave height versus distance from the leading edge of the RIB system. Incident waves in the photograph above scaled to mid- to upper-sea state 3, while the wave climate in the lee of the RIB system scaled to sea state 1.
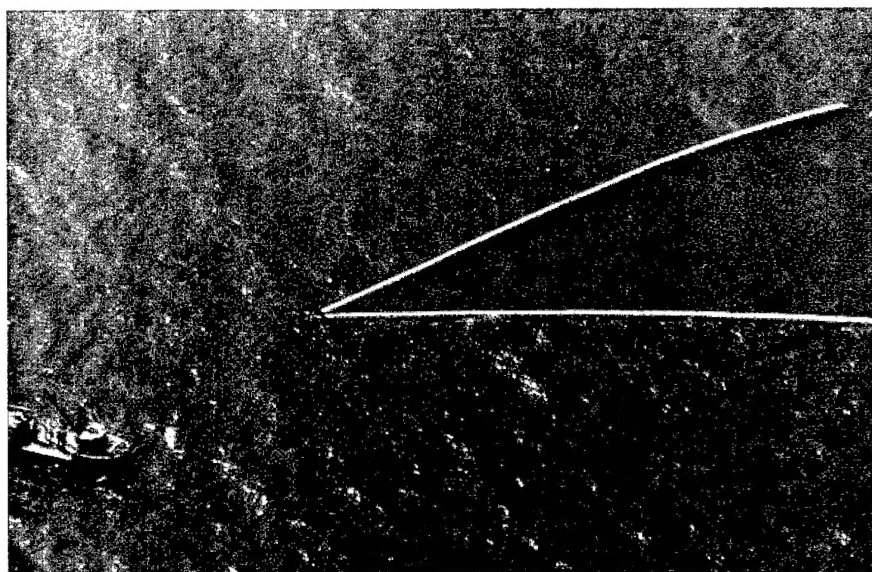

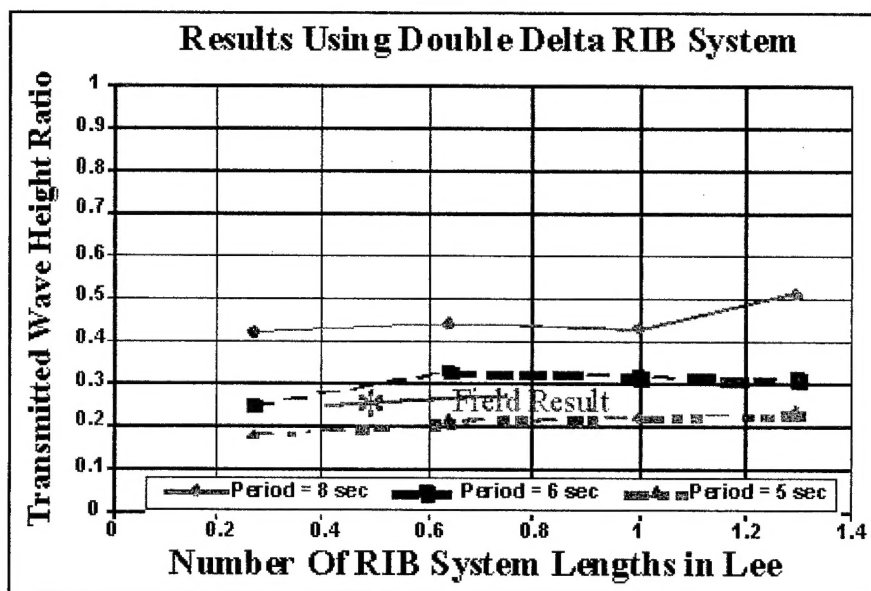*Figure 4. RIB system during 1996 field deployment at Duck, NC*

Results Using Double Delta RIB System

Field Result

Period = 8 sec   Period = 6 sec   Period = 5 sec

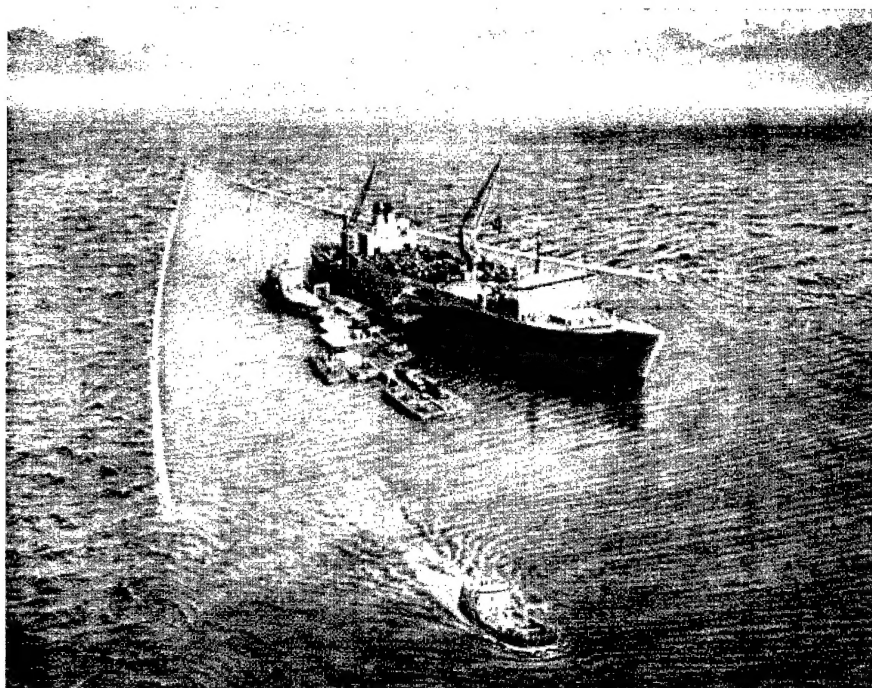*Figure 5. Wave height reduction observed in laboratory and field experiments*

Figure 6. Artist's concept of RIB system during typical roll-on/roll-off operation at sea state 3 conditions

Future Plans

The next step in the development of the RIB system will be additional laboratory investigations to study deployment options, construction materials, and mooring requirements. These efforts will be followed by the construction and field deployment of a larger, 1-to-3 scale version in August 1997 in Pensacola Bay near Pensacola, FL. This will be followed by design, construction, and deployment of a full-scale version during an actual LOTS exercise.

Additional plans are being developed to produce a smaller, less expensive, easier-to-deploy version of the RIB system which could be used in nonmilitary applications at various locations around the United States (and world). Typical operations or applications which could be enhanced by such a product include rescue and recovery operations, exposed marine construction operations (such as bridge repair or rubble-mound breakwater construction), temporary small vessel/watercraft shelter from energetic sea conditions, and exposed dredging operations. Preliminary laboratory results obtained with a significantly smaller RIB system (leg length about 1/4 of that required for the military version) have shown great promise, with best results demonstrating wave height reduction on the order of about 60 percent in the system's lee.

Summary

Based on results obtained from extensive laboratory studies and observations made during a field study in May-June 1996, the RIB system being developed by WES holds great promise for alleviating the military's ship offloading problems associated with higher sea states during LOTS operations. An artist's rendition of the RIB system deployed in conjunction with an RO/RO offload operation is shown in Figure 6.

Acknowledgments

EST - A New Approach to Frequency Analysis

by Norman W. Scheffner[1] and H. Lee Butler[2]

Introduction

Recreation is a vital industry to many countries of the world, with coastal areas representing primary attractions for both residents and tourists. Unlike many other regions, coastal areas are subject to storm events which can significantly impact the condition of the beach, often rendering it unacceptable for recreational use. As a result, there exists a need to provide an adequate, yet affordable, level of protection against coastal erosion and inundation. Design and construction of coastal structures require accurate estimates of the frequency and severity of storm events and their respective damages.

The empirical simulation technique (EST) is a "bootstrap-based" statistical procedure for simulating multiple time sequences of nondeterministic multiparameter systems such as storm events, and their corresponding impacts to the environment. An application of the approach for computing frequency relationships for tropical and extratropical storm-induced flooding of the southern Long Island coast is described.

Empirical Simulation Technique

Many past attempts to assign frequency relationships to hurricanes were based on the assumption that hurricane parameters are independent, and that their individual probabilities can be modeled with empirical, or parametric, relationships. The joint probability of occurrence for a particular storm was then computed as the product of the individual storm parameter probabilities via assumed parametric relationships. This assumption is the primary basis of the joint probability method (JPM). Some of the difficulties associated with application of the JPM for storm-related damages are that storm parameters are based on a very sparse data set (10 storms were used in an early study of the Long Island coast). Next, each parameter in turn is varied while holding the other four parameters fixed. This results in a large population of storms, many of which are probably unrealistic. There is also a question about the interdependence of parameters. In the earlier Long Island study, a relationship between the central pressure and track was determined and probabilities were adjusted accordingly. These weaknesses are overcome by the EST approach.

The EST utilizes observed and/or computed parameters associated with site-specific historical events as a basis for developing a methodology for generating multiple life-cycle simulations of storm activity and the effects associated with each simulated event. Contrary to the JPM, the technique does not rely on assumed parametric relationships but uses the joint probability relationships inherent in the local database. Therefore, in this approach, probabilities are site-specific, do not depend on fixed parametric relationships, and do not assume parameter independence. Thus, the EST is "distribution free" and nonparametric.

EST is based on a "bootstrap" resampling-with-replacement, interpolation, and subsequent smoothing technique in which random sampling of a finite length database is used to generate a larger database. The only assumption is that future events will be statistically similar in magnitude and frequency to past events. EST begins with an analysis of historical events which have impacted a specific locale. The selected database of events is then parameterized to define the characteristics of the event and the impacts of that event. Parameters which define the storm (like the central pressure, radius to maximum winds, and so on for hurricanes) are referred to as input vectors. Response vectors define storm-related damages such as inundation and shoreline/dune erosion. These input and response vectors are then used as a basis for generating life-cycle simulations of storm event activity. Details of the approach can be found in Scheffner and Borgman (1996).

EST Implementation

The following data were used in formulating goals for EST:

- Historical data (e.g., central pressure, track, tidal phase, duration, wave height and period, etc.).

- "Training set" data of actual and perturbed (e.g., slightly altered paths) historical events.

- Response vectors calculated from the training set.

Based on these data, it is the goal of EST to produce N simulations of a T-year sequence of events, each with their associated input and response vectors via EST capability to interpolate responses for any storms not in the training set computed from the responses of the training set.

Two criteria are required of the T-year sequence of events. The first criterion is that the individual events must be similar in behavior and

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magnitude to historical events; i.e., interrelationships among the input and response vectors must be realistic. The second criterion is that the frequency of storm events in the future will remain the same as in the past.

EST is not simply a resampling of historical events technique, but rather an approach intended to simulate the vector distribution contained in the training set database population. The EST approach selects a sample storm based on a random number selection from 0 to 1, and then performs a random walk from the event X with certain response vectors to the nearest neighbor vectors. The walk is based on independent uniform random numbers from -1 to 1 and has the effect of simulating responses which are not identical to the historical events but are similar to events which have historically occurred.

EST Application to Long Island

Over a decade ago a then-state-of-the-art hydrodynamic model was used to compute storm surge impacting the New York Bight and Long Island coast. The stochastic method of choice was the JPM, as in many similar studies conducted at that time. Now, more than a decade later, we have had a unique opportunity to revisit this work and apply state-of-the-art hydrodynamic and stochastic technologies. Flood protection for several areas along the Fire Island to Montauk Point (FIMP) coastal reach has significantly been reduced by erosion of beaches and dunes relative to 1980 protection levels. Hence, new calculations are warranted, even if the result is a validation of previous results.

A major issue in the earlier study was lack of computer resources; most of the computations were made on a CDC 7600. However, today we have a CRAY C-90 or better at our disposal with vastly increased speed and memory. It was intractable to construct a single grid extending from beyond the continental shelf to the nearshore and

back-bay areas of Long Island with sufficient resolution to capture inlet conveyance, bay effects, and barrier island overtopping. Thus, a coarse global grid composed of over 3,500 cells was constructed to cover the New York Bight from a point south of Atlantic City, NJ, to beyond Cape Cod, MA, (and includes New York Harbor and Long Island Sound). The purpose of the global grid was to model large-scale tidal and storm events, providing results for input to a nearshore domain, high-resolution, 4,100-cell grid of the main study area. The high-resolution grid stretches from near Jones Inlet to beyond Shinnecock Inlet (including all back-bay and channel systems) and had variable grid size resolution of 200 to 1,200 m. Even with this resolution it was difficult to obtain a good calibration of the model to measured water levels and velocities.

A finite-element hydrodynamic model named ADCIRC (ADvanced CIRCulation), was applied in the new FIMP study on an unstructured grid for all storm event simulations. A key advantage of an unstructured grid is the ability to specify sparse resolution in areas of deep bathymetry and high resolution in shallow areas or near complex boundaries. Figure 1 displays the gridded computational domain for the revised study. In this 15,000-node grid, the offshore boundary to the east is placed at 60° west longitude while the southern boundary is placed at approximately 26° north latitude. An enlargement of Fire Island Inlet in the study area shown in the figure demonstrates the ability to provide high grid resolution where necessary. The ADCIRC model was validated on this grid for the M_2 tidal constituent and for several historical tropical and extratropical events.
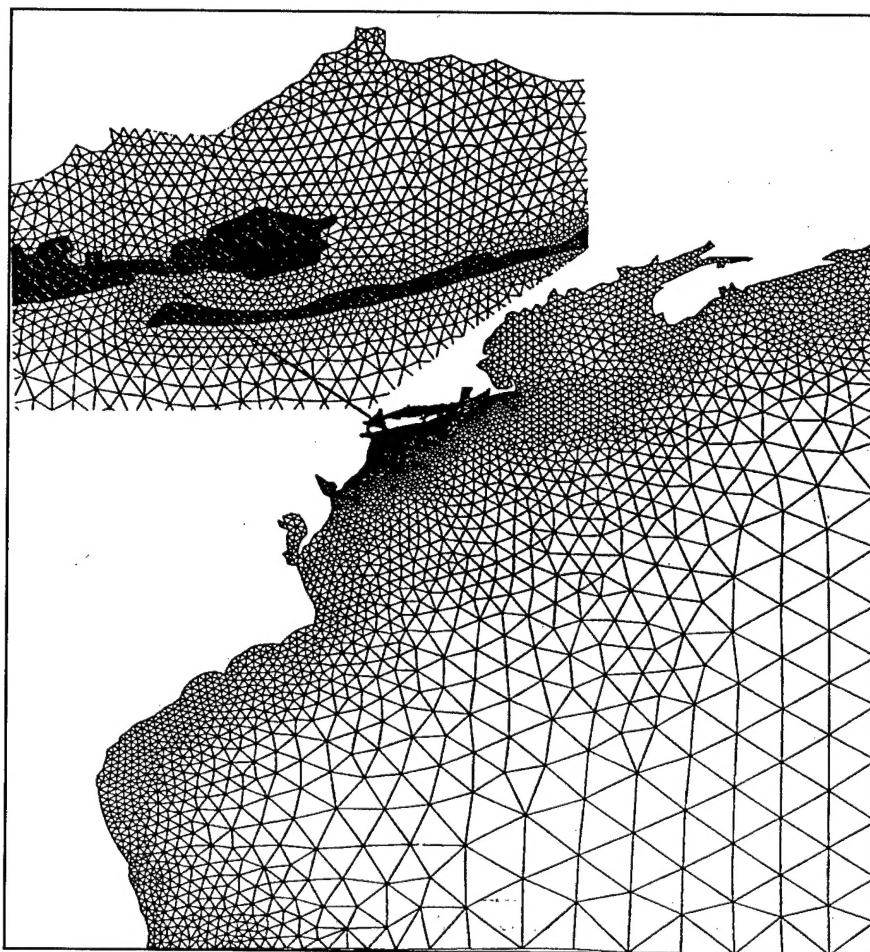

Figure 1. ADCIRC computational domain

All backbay areas are highly refined and inlet features are fully resolved with grid node spacing as small as 50 m. The computer system used for the calculations was the CRAY C-90. This machine has 16 parallel processors, each of which has a performance rating of over 1 gigaflop. The previous finite difference model was run on a CDC 7600, which had a performance rating below 10 megaflops, resulting in a gain of over 1,000 in performance with the new machines. The lack of computer power in 1980 highly influenced selection of a dual-grid approach in the earlier study, whereas in the new study a single-grid approach was used.

The training set used in the EST analysis consisted of both tropical and extratropical storms. Tropical events included 16 historical hurricanes and 4 altered historical events; 9 historical northeasters were considered. This article is limited to a discussion of the tropical event analysis in which the 20 storm events were simulated with ADCIRC to generate an array of response vectors for each location at which stage-frequency relationships were desired.

Figure 2 displays the tropical event stage-frequency relationships computed for Sandy Hook, NJ, located at the ocean entrance to New York Harbor. Because the EST is a multiple life-cycle simulation approach, multiple stage-frequency relationships are generated, each corresponding to a separate simulation. In the present analysis, 100 simulations of a 200-year simulation of storm activity were generated. Mean value relationships are computed with error estimate bounds defined as plus/minus one standard deviation. These values are indicated in Figure 3 which displays the analyzed stage-frequency curve for Sandy Hook. Also included on the figure are points representing the tropical event curve from calculations in the 1980 study. As shown, the EST-generated relationship is below that generated in the original FIMP study; however, the original results are approximately within the error limits of the EST results.
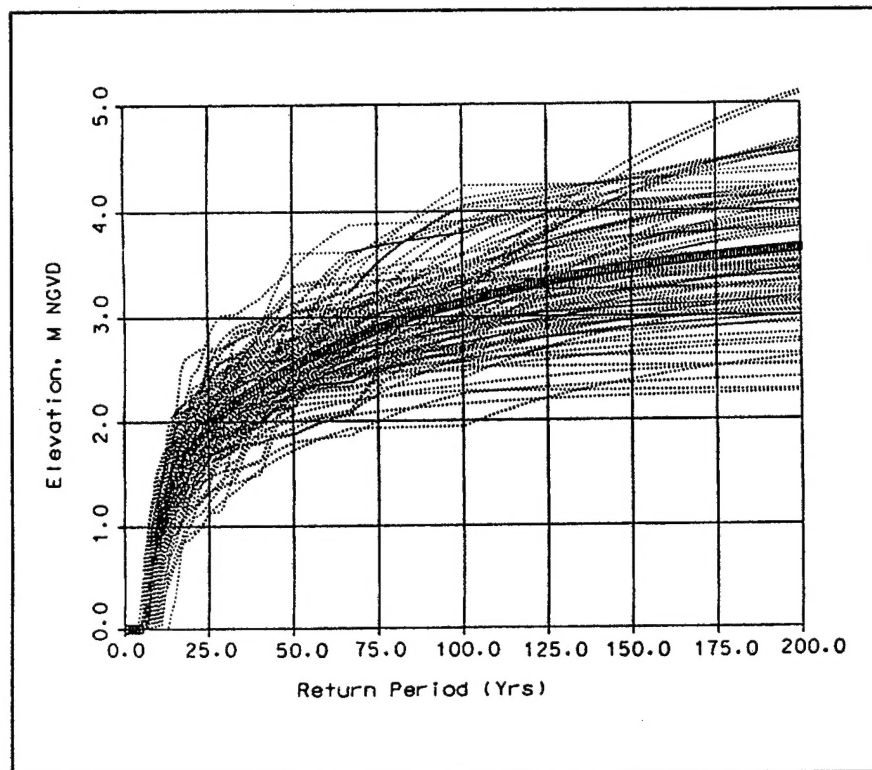

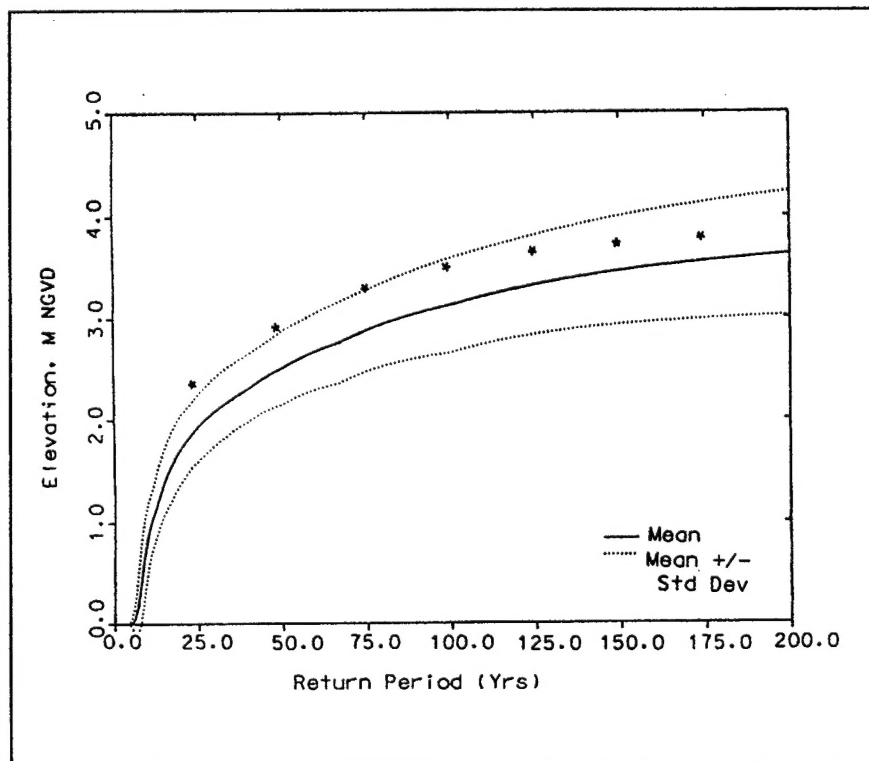Figure 2. Tropical event stage-frequency relationships, Sandy Hook, NJ

Figure 3. Stage-frequency curve, Sandy Hook, NJ

Calculations were made for various locations along the southern Long Island coast and within all back-bay areas.

Discussion

While the methodology used in the earlier study was innovative more than a decade ago, significant drawbacks and problems were encountered. Successful simulations of open coast surge were made but it was difficult to accurately model hydrodynamics in back bay areas as well as barrier overtopping. The study was unable to determine the influence of the JPM assumptions on the slope of the exceedence curve for tropical events. How important was the influence of "unrealistic storms," which were included of necessity in the storm ensemble? What impact did ignoring the interdependence of tropical storm parameters have? These questions were never answered satisfactorily.

The hydrodynamic and stochastic modeling approaches used in the revisited FIMP study represent a great improvement over the techniques employed in the original study. As a result, the major difficulties encountered in the first study were eliminated; (a) the need for two computational grids, (b) inaccurate modeling of inlet, back-bay, and barrier overtopping hydrodynamics, and (c) necessary assumptions of parameter independence and inclusion of unrealistic storm events. The cost (in 1997 dollars) for conducting the new study was less than half the cost (in 1980 dollars) of the earlier study because of efficiency in new technology.

It is noted that the stage frequency relationship generated for Sandy Hook is lower than that generated in the original study. The tropical events used in the present study should represent realistic events which impact the study area. Therefore, EST-based results should be more accurate than JPM-based results. The higher levels found in the earlier study may be due to the fact that the JPM events represent combinations of storm parameters which are not truly representative of the study area. Since the extratropical events dominate the lower end of the curve (lower return periods), this impact may not have been consequential. Further research is required to define sufficiency of the training set of storms (input response vectors) as well as how to best define life-cycle scenarios. How far you go in breaking down probabilities associated with historical events by including slight perturbations of these events (altered track or another appropriate parameter) is still unknown at this time.

Acknowledgments

References

Scheffner, N. W., and Borgman, L. E. (1996). The empirical simulation technique; a bootstrap-based life-cycle approach to frequency analysis. *Proceedings, 7th IAHR International Symposium on Stochastic Hydraulics*, MacKay, Australia, 29-31 July 1996.

CERCular Available on Internet

CERCular issues since December 1995 are available on the World Wide Web (WWW), located at http://bigfoot.cerc.wes.army.mil/c130.html. The text of the WWW version and the paper version are identical; some photographs appearing in the paper version are not necessarily reproduced in the WWW version. Color photographs will be included in the WWW version where available. Future issues of the CERCular will appear on the WWW approximately 30 days prior to delivery by surface mail. If you no longer wish to receive the paper version of the CERCular, please notify Lyndell Z. Hales at email l.hales@cerc.wes.army.mil, or by mail at:

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Address changes or submission of material for inclusion in the CERCular should also be directed to the above.

Tenth Corps of Engineers Coastal Engineering Workshop Held in San Francisco

The 1997 Corps of Engineers Coastal Engineering Workshop was held 20-21 May in San Francisco, CA. This was the tenth workshop to be held since the first in 1983, where it was decided that Corps personnel involved in coastal engineering applications and research should meet at least once every 2 years to integrate and coordinate their activities and thus promote increased efficiency and effectiveness of laboratory products and state-of-the-art applications. The workshop focused on problem area topics related to Coastal/Estuarine Navigation and Sediment and Management. Case studies on projects utilizing innovative approaches to problems in these areas were presented by Corps field offices. Group discussion between Corps Headquarters, field, and laboratory personnel after each topic provided direct interaction between attendees where experiences and/or engineering solutions were shared.

Coastal Engineering Research Board Meets in Chicago

The 65th meeting of the Coastal Engineering Research Board (CERB) was held on 24-26 June 1997, in Chicago, IL. The CERB is Congressionally mandated to advise the Chief of Engineers on all matters related to coastal engineering. The Board meets twice a year in different geographical areas. The spring meeting is a full meeting of the Board, while the fall meeting format allows the civilian members to have a better understanding of the workings and problems of the host Division.

The Board is comprised of seven members. The President of the Board is MG Russell L. Fuhrman, Director of Civil Works. The other three military members are MG Milton Hunter,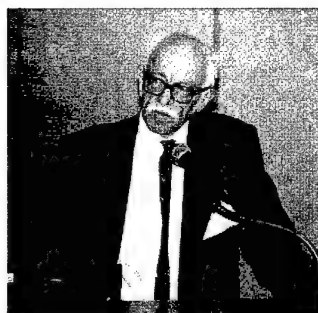 Commander, North Atlantic Division; BG Henry S. Miller, Jr., Commander, Southwestern Division; and BG J. Richard Capka, Commander, South Pacific Division. The three civilian members are Dr. Robert G. Dean, University of Florida; Dr. Edward K. Noda, Edward K. Noda and Associates, Inc., Honolulu, HI; and Dr. Richard W. Sternberg, University of Washington. The Commander of the U.S. Army Engineer Waterways Experiment Station acts as the Executive Secretary of the CERB and is responsible for all administrative functions of the Board.

The meeting was hosted by the Great Lakes Regional Office of the Great Lakes and Ohio River Division (LRD-GL) and the Chicago District (LRC). The theme was "Coastal Engineering in the Great Lakes." Speakers and panelists were from the Board; Headquarters, U.S. Army Corps of Engineers; LRD-GL; Buffalo District; LRC; Detroit District; academia; and the private sector. Presentations were given and discussions held on various topics pertaining to the theme of the meeting, as well as LTG Joe N. Ballard's Strategic Vision for the Corps of Engineers and the strategic plan for coastal engineering.

Proceedings of the meeting will be located on the World Wide Web. Since the proceedings will be on the Internet, hard copies will no longer be routinely sent to Corps offices or attendees. Hard copies may be obtained from Ms. Sharon L. Hanks, U.S. Army Engineer Waterways Experiment Station, Coastal and Hydraulics Laboratory, (601) 634-2004.

Fourth Federal Waterways R&D Coordination Conference

The Interagency Committee on Waterways Management (ICWWM) sponsored the Fourth Federal Waterways R&D Coordination Conference on May 20–22, 1997. The conference was hosted by the Naval Surface Warfare Center (NSWC), Carderock Division, Bethesda, MD. The purpose of the conferences is to encourage coordination of research and development by federal agencies with waterways management responsibilities. These agencies include the Army Corps of Engineers, Coast Guard, Environmental Protection Agency, Maritime Administration, Minerals Management Service, National Imaging and Mapping Agency, National Oceanic and Atmospheric Administration, and the Navy. There were approximately 130 attendees, including representatives of federal and state agencies as well as a number of waterway users. The theme of this year's conference was "Focus on User Needs." This was the first year the conference was open to non-federal employees, and the intent was for those engaged in waterway research to learn more about user and stakeholder issues and concerns, and for waterway users to gain a better understanding of federal research and development efforts.

Attendees were welcomed to the conference by CAPT James Baskerville, Head of NSWC, Carderock Division, and by RADM Robert North, Assistant Commandant for Marine Safety and Environmental Protection, U.S. Coast Guard. RADM North also serves as Chairperson of the ICWWM. The first day sessions consisted of a challenge speaker and panel discussion in three areas; (a) Navigation/Information Systems, (b) Waterway Infrastructure, and (c) the Environment. During the second day federal researchers gave short presentations on approximately 25 current waterways research projects. These technical sessions also addressed the same general subjects of Navigation/Information, Infrastructure, and the Environment. Each of these sessions concluded with a round-table discussion which focused on how well the research is addressing user needs, and what might be done to make the research more responsive and the research process more efficient. The third day started with a plenary session in which the technical session moderators presented a summary of the working sessions. This was followed by a wrap-up session in which the attendees discussed the lessons learned from the conference, and identified areas for improvement and cooperation in federal waterways research and development. In the afternoon, attendees were shown capabilities of the David Taylor Model Basin and other unique research facilities at the NSWC. Closing remarks were provided by RADM North.

Both waterway users and federal researchers found this to be a very useful conference. Users indicated that most, if not all, of the research described had many potential benefits by making marine transportation safer, easier, and/or more efficient. Federal researchers gained a better understanding of user needs and concerns. Two consistent themes that the users expressed were the need for integration of the variety of marine safety and transportation information so that it is useful and useable on the vessel, and the desire for implementation of some of the more advanced technology that has been under development but has yet to find its way to the users on the waterways.

The Interagency Committee on Waterways Management met immediately following the conference. The R&D Subcommittee, which serves as the conference steering committee, presented a summary of the conference and proposed some specific follow-on actions based on the wrap-up session and lessons learned. As a result, the ICWWM agreed in principle to pursue two projects; one will address the issue of information integration through a pilot project in a specific port, and the second will seek to develop a port master plan for infrastructure renewal, development, and waterways management. Federal agencies will partner with port and state officials to develop this plan, which should be a model for other ports to use in the future.

Details of this conference, including transcripts of the challenge speech, technical presentations, and other proceedings may be found on the World Wide Web on the Coast Guard Research and Development Center's home page at www.rdc.uscg.mil. The next Federal Waterways R&D Coordination Conference will be hosted by the Maritime Administration and is being planned for March 1999. Details will be posted on the web site as they become available.

Wave Information Study (WIS) Time Series Format Change

The format of the time series data for the U.S. Army Engineer Waterways Experiment Station (WES), Wave Information Study (WIS) is being revised, primarily to accommodate the approaching millennium. The current format uses a two-digit format to represent the year. To avoid sequencing/ referencing problems, and other difficulties that may arise with the year 2000, the new format will use four digits to indicate the year. Other format changes being implemented will remove extraneous decimals to reduce overall file storage requirements. All existing WIS time series files will be revised to reflect these changes. All future WIS time series data files will be archived using the new format. The new format will be implemented beginning 1 October 1997. The new concise format will result in a 10-percent reduction in file size.

WIS time series data are available as part of the WES Coastal Engineering Data Retrieval System (CEDRS) via anonymous file transfer protocol (FTP) on the World Wide Web. Instructions to download the data can be found at http://bigfoot.cerc.wes.army.mil/ c201.html. Questions relating to the WIS format changes or downloading of data via anonymous FTP may be directed to Doyle L. Jones at email d.jones@cerc.wes.army.mil.

First Completed CORE-LOC™ Project Port St. Francis, South Africa

CORE-LOC™ is one of the most effective concrete units ever developed for armoring breakwaters, jetties, and revetments due to its efficient use of concrete, its robust shape, and its reserve hydraulic stability. CORE-LOC™ was developed at the Coastal and Hydraulics Laboratory, U.S. Army Engineer Waterways Experiment Station, in 1992 and patented in 1995. The first CORE-LOC™ armored structures to be built are now protecting Port St. Francis, in St. Francis Bay, South Africa, located on the Indian Ocean side of the African continent. Port St. Francis is a privately developed small craft harbor, marina, and condominium resort. The two protective structures armored with CORE-LOC™ include a breakwater and peninsula revetment, requiring 560 and 260 CORE-LOC™ units, respectively. Details of the design and construction of the units, and development of the breakwater and revetment will appear in the next issue of the CERCular.
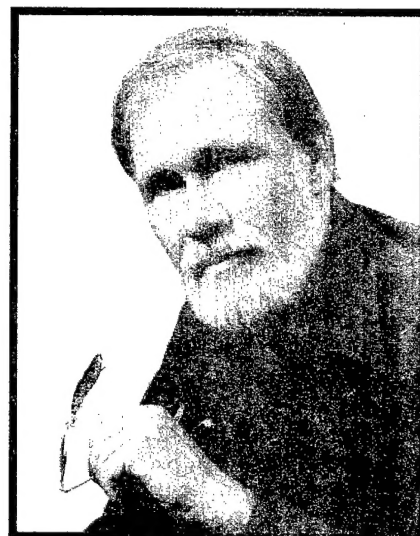
Robert H. Campbell
1937–1997

Robert H. Campbell, former Chief of the Dredging and Navigation Branch, Headquarters, U.S. Army Corps of Engineers, died in Drasco, Arkansas, on June 18, 1997. Bob had a long and distinguished career in the Corps beginning with the Vicksburg District. He worked his way through the ranks in the District to become the Assistant Chief of the Operations Division prior to his Headquarters appointment in 1990. Bob was a tremendous supporter of research and development, and was actively and directly involved in the development of the Dredging Operations and Environmental Research Program. Bob was a real "people" person with a wide range of interests. He was equally at home talking with a deck hand or a high political office holder.

Bob is survived by his wife Sandra, three sons, and seven grandchildren. He will be missed by the entire Corps family and by his many other friends.

Bernard LeMéhauté
1927–1997

Dr. Bernard LeMéhauté, Professor Emeritus of Applied Marine Physics and former Chairman, Department of Ocean Engineering, Rosenstiel School of Marine and Atmospheric Science, University of Miami, and former member of the Coastal Engineering Research Board (CERB), died in Miami, Florida, on July 7, 1997. Bernie was a world-renowned leader in coastal engineering, as reflected by his election to membership in the National Academy of Engineering. Among his many awards, he was the first recipient of the American Society of Civil Engineers Mauricio Porraz International Coastal Engineering Award and the first recipient in engineering of a Creative Award by the National Science Foundation. His textbook *Hydrodynamics and Water Waves* was published in English, Russian, Japanese, and Spanish. He pioneered and developed the state of the art in the prediction of waves generated by underwater nuclear explosions. He was a very active member of the CERB, having served on several panels and task forces and provided one-on-one guidance and advice to Corps researchers.

Bernie is survived by his wife Marie Josseline, two children, and two grandchildren. His loss will be felt by the entire coastal engineering community, as well as by his many other friends and colleagues worldwide.

Calendar of Coastal Events

September 7–11, 1997 **International Conference on Contaminated Sediments: Restoration and** Management, Rotterdam, Netherlands, POC: Conference Secretariat, P.O. Box 1558, 6501 BN NIJMEGEN, The Netherlands, Fax (3124) 360 1159

September 7–11, 1997 **Pacific Coasts and Ports 97**, incorporating **13th Australasian Coastal and Ocean Engineering Conference** and the **6th Australasian Port and Harbour Conference,** Christchurch, New Zealand, POC: Megan O'Brien, P.O. Box 10330, Christchurch, New Zealand, Phone 64 3 379 0390, 64 3 379 0460, E-Mail j.lumsden@cae.canterbury.ac.nz

September 16–19, 1997 **Fifth Symposium on the Biogeochemistry of Wetlands,** Royal Holloway and Bedford New College, University of London, London, England, Co-sponsors: Louisiana State University, Wetland Biogeochemistry Institute; and University of Florida, Institute of Food and Agricultural Sciences; POC: Karen Gros, Louisiana State University, Phone (504) 388-8810, Fax (504) 388-6423; Royal Holloway Institute for Environmental Research, Fax +44 (0) 1784 477427, E-Mail rhier@rhbnc.ac.uk

October 6–9, 1997 **Oceans 97**, Halifax, Nova Scotia, Canada, POC: E-Mail oceans97@sirius.ns.ca; http://www.sirius.ns.ca/oceans97; http://www.ieee.org/conference/conflinks.html

October 12–15, 1997 **Coastal Science and Management: Making Coastal Research Count,** National Conference of the American Shore and Beach Preservation Association, Hauppauge, Long Island NY, USA, POC: Henry Bokuniewicz, Marine Sciences Research Center, State University of New York, Stony Brook, NY 11794-5000

October 22–24, 1997 **5th International Conference on Estuarine and Coastal Modeling**, Alexandria, VA, USA, POC: Malcom L. Spaulding, 215 Sheets Building, University of Rhode Island, Narragansett, RI 02882-1197, phone (401) 874-6666, fax (401) 874-6837, e-mail spaulding@oce.uri.edu

October 22–24, 1997 **Docks and Marinas '97: Marina Design for the 21st Century,** Madison, Wisconsin, USA, POC: C. Allen Wortley, Course Director, University of Wisconsin-Madison, 432 North Lake Street, Suite 807, Madison, WI 53706-1498, phone (608) 262-0577, fax (608) 263-3160, email wortley@engr.wisc.edu

October 27–29, 1997 **Bordomer '97: Coastal Environment Management and Conservation,** Bordeaux, France, POCs: J.-P. Baste, BORDOMER, Hotel de Region, 14, rue Francois-de-Sourdis, 33077 BORDEAUX Cedex, France, phone 33 (0) 5 56 90 53 12, fax 33 (0) 5 56 24 72 80

October 27–31, 1997 **Fundamentals of Coastal Engineering**, Vicksburg, MS, USA, POC: Yen-hsi Chu, U.S. Army Engineer Waterways Experiment Station, Coastal and Hydraulics Laboratory, Vicksburg, MS 39180-6199, phone (601) 634-2067, e-mail y.chu@cerc.wes.army.mil or dooleyj@smtp.hnd.usace.army.mil

October 28–30, 1997 **PIANC Annual Conference: U.S. Section, Permanent International Association of Navigation Congresses,** Wilmington, NC, USA, POC: Thomas Ballentine, U.S. Section PIANC, Casey Bldg., 7701 Telegraph Road, Alexandria, VA 22315-3868, phone (703) 428-7072, fax (703) 428-8171

November 3–7, 1997 **Waves 97: Third International Symposium on Ocean Wave Measurement** and Analysis, Virginia Beach, VA, USA, POC: Billy Edge, Ocean Engineering Program, Texas A&M University, College Station, TX 77843-3136, phone (409) 847-8712, fax (409) 862-1542, e-mail b-edge@tamu.edu

November 11–14, 1997 **MEDCOAST 97: Third International Conference on the Mediterranean** Coastal Environment, Qawra, Malta, POC: Cigdem Gencel, MEDCOAST Secretariat, Middle East Technical University, 06531 Ankara, Turkey, phone (90 312) 210 54 29/30/35, fax (90 312) 210 14 12, e-mail medcoast@rorqual.cc.metu.edu.tr

November 18–22, 1997 **Europort '97, and CEDA Dredging Day,** Amsterdam, Netherlands, POC: Michel Arends, Project Manager, Europort '97, RAI International Exhibition and Congress Centre, P.O. Box 77777, 1070 MS Amsterdam, Netherlands, phone +31 (0) 20 549 12 1 2, fax +31 (0) 20 646 44 69; Anna Csiti, Manager, CEDA, P.O. Box 3168, 2601 DD Delft, Netherlands, phone +31 (0) 15 278 31 45, fax +31 (0) 15 278 71 04

December 8–12, 1997 **American Geophysical Union, Fall Meeting,** San Francisco, CA, USA.

January 5–9, 1998 **27th Annual Dredging Engineering Short Course**, College Station, TX, USA, POC: Robert E. Randall, Center for Dredging Studies, Texas A&M University, College Station, TX 77843-3136, phone (409) 845-4515, fax (409) 862-1542